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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/016,661	10/29/2001	Remis Balaniuk	S00-226/US	3916

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EXAMINER	
GEBRESILASSIE, KIBROM K	
ART UNIT	**PAPER NUMBER**
2128	

DATE MAILED: 01/31/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	10/016,661	BALANIUK ET AL.
	Examiner	Art Unit
	Kibrom K. Gebresilassie	2128

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 September 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-35* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Prosecution on the merits of this application is reopened on claims 1-35. The previous final rejection of claims 1-35 is hereby withdrawn. Claims 1-35 are currently pending in this application.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1 and 2 are rejected under 35 U.S.C. 103(a) as being unpatentable Xunlei Wu, Michael Downes, Tolga Goktekin, and Frank Tendick, " Adaptive Nonlinear Finite Elements for Deformable Body Simulation Using Dynamic Progressive Meshes", Eurographics 2001, Vol. 20, No. 3, herein referred to as **Wu**, in view of "Preliminary Finite Element Analysis With SAGE", 2000, herein referred to as **PFEAS**.

As per claim 1:

Wu discloses Long Elements Method (LEM) for real time physically based modeling of a deformable medium (Abstract), comprising the steps of: configuring said computer with a meshing strategy based on b.sup.2 where b is length of a side of said deformable medium thereby substantially reducing number of time steps required by said modeling (*These matrices are generally...;* page 2, left side column, lines 10-12).

Wu fails to disclose constructing a plurality of long element in a computer.

PFEAS discloses constructing a plurality of long element in a computer (page 327, under a title "B.3 Shearing of a Thin 2-Delement of Soil Bentonite" lines 1-2).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teachings of Wu related to produce a diagonal mass matrix that allows real time computation with the teachings of PFEAS related to perform verification of the RS model in SAGE, analysis of arching in a soil Bentonite cutoff wall, and shearing of thin 2-D element of soil bentonite. The motivation for doing so would have been more convenient to show reasonable stress-strain behavior (page 327 lines 14-15). Hence a skilled artisan having access to the teaching of Wu and PFEAS would have knowingly modified the teaching of Wu with PFEAS.

As per claim 2:

Wu discloses a soft tissue (page 2, left side column, line 17).

4. Claims 3-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xunlei Wu, Michael Downes, Tolga Goktekin, and Frank Tendick, " Adaptive Nonlinear Finite Elements for Deformable Body Simulation Using Dynamic Progressive Meshes", Eurographics 2001, Vol. 20, No. 3, herein referred to as **Wu**, and "Preliminary Finite Element Analysis With SAGE", 2000, herein referred to as **PFEAS** as applied to claims 1 and 2 above, and further in view of Sara Gibson, Christina, Eric Grimson..., Volumetric Object Modeling for Surgical Simulation, MIT, 5 November 1997, herein referred to as **Gibson**.

As per claim 3:

Wu fails to disclose deformable medium is an object filled with fluid.

Gibson discloses an object filled with fluid (page 2 paragraph two lines 10-11).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teachings of Wu related to produce a diagonal mass matrix that allows real time computation with the teachings of Gibson related to modeling phenomena such as the deformation, cutting, tearing, or repairing of soft tissues poses significant challenges for real-time interaction. The motivation for doing so would have been more convenient to deforming volumetric object models, for detecting collisions between volumetric objects and for modeling tissue cutting (page 2, lines15-16). Hence a skilled artisan having access to the teaching of Wu and Gibson would have knowingly modified the teaching of Wu with Gibson.

As per claim 4:

Gibson discloses soft tissue simulation, surgical simulation, unrestricted multi-modal interactive simulation including simulating interactive topological changes, volumetric modeling for homogeneous and non-homogeneous materials, and graphic and haptic rendering (Abstract).

As per claim 5:

Gibson discloses the method of claim 1, further comprising a step of: providing means for simulating deformations and dynamics of said deformable medium (page 4 lines 1-3 and the equation).

As per claim 6:

Gibson discloses the method of claim 5, wherein said deformations include elastic and plastic deformations and said dynamics include movement of said deformable medium (page 5 paragraph three lines 6-7).

As per claim 7:

Gibson discloses providing means for simulating elastic deformations of said deformable medium (page 5 paragraph three lines 6-7), wherein said deformable medium is an object filled with fluid (page 2 paragraph two lines 10-11).

As per claim 8:

Gibson discloses a set of static equations (*Ku=F*; page 3 equation 1), volume conservation (Abstract lines 5-6).

Gibson fails expressly to disclose a Pascal principle. However, this feature is, which is a Pascal Principle, deemed to be obvious to the Gibson system as shown in page one paragraph two of "Introduction". In order to cut the soft tissue in a surgical simulation, it is important to find out how much pressure should be applied to over come the inside pressure of the tissue. At this moment the Pascal Principle plays a big role in the surgical simulation. Without having this Principle, it would be impossible to know the external applied force without knowing the internal and external pressure of the soft tissue at the time of surgical simulation.

As per claim 9:

Gibson discloses the method of claim 8, wherein each of said static equations is an equilibrium equation (*Ku=F*; page 3 equation 1), defined for each of said plurality of long elements using material properties comprising pressure, volume (abstract line 10),

stress (Fig. 3), strain (Fig. 3), position (displacement u; page 4, a paragraph starting with "In both static and dynamic..." line 1), and velocity (first order derivative of u; page 4, a line starting with "where M and C are..." line 1).

As per claim 10:

Wu discloses Long Elements Method (LEM) for real time physically based simulation of a deformable object (Abstract), comprising the steps of: discretising volume of said deformable object with b.sup.2 where b is length of a side of said deformable object (*These matrices are generally...;* page 2, left side column, lines 10-12);

Wu fails to disclose plurality of long elements; providing a set of static equations wherein each of said static equations is defined for each of said plurality of long elements using dynamic variables; and providing a static stateless deformation engine for simulating globally and physically consistent elastic deformations of said deformable object.

PFEAS discloses plurality of long element in a computer (page 327, under a title "B.3 Shearing of a Thin 2-Delement of Soil Bentonite" lines 1-2).

Gibson discloses providing a set of static equations wherein each of said static equations is defined for each of said plurality of long elements using dynamic variables (page 4 the line starting with "In both static and dynamic simulations, ..." lines 1-2); and providing a static stateless deformation engine for simulating globally and physically consistent elastic deformations of said deformable object (page 5 paragraph 3).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teachings of Wu related to produce a diagonal mass matrix that allows real time computation with the teaching of PFEAS related to perform verification of the RS model in SAGE, analysis of arching in a soil Bentonite cutoff wall, and shearing of thin 2-D element of soil bentonite and with the teachings of Gibson related to modeling phenomena such as the deformation, cutting, tearing, or repairing of soft tissues poses significant challenges for real-time interaction. The motivation for doing so would have been more convenient to deforming volumetric object models, for detecting collisions between volumetric objects and for modeling tissue cutting (**Gibson**, page 2, lines15-16). Hence a skilled artisan having access to the teaching of Wu, PFEAS and Gibson would have knowingly modified the teaching of Wu with PFEAS and Gibson.

As per claim 11:

Gibson discloses a set of static equations (*Ku=F*; page 3 equation 1), volume conservation (Abstract lines 5-6).

Gibson fails expressly to disclose a Pascal principle. However, this feature is, which is a Pascal Principle, deemed to be obvious to the Gibson system as shown in page one paragraph two of “Introduction”. In order to cut the soft tissue in a surgical simulation, it is important to find out how much pressure should be applied to over come the inside pressure of the tissue. At this moment the Pascal Principle plays a big role in the surgical simulation. Without having this Principle, it would be impossible to know the

external applied force without knowing the internal and external pressure of the soft tissue at the time of surgical simulation.

As per claim 12:

Gibson discloses dynamic variables representing quantities that vary significantly during simulation (page 4 lines 1-3 and the Formula in page 4), said dynamic variables simulation (page 4 lines 1-3 and the Formula in page 4) comprising pressure, volume (abstract line 10), stress (Fig. 3), strain (Fig. 3), position (displacement u; page 4, a paragraph starting with "In both static and dynamic..." line 1), and velocity (first order derivative of u; page 4, a line starting with "where M and C are..." line 1).

As per claim 13:

The limitation of claim 13 has already been discussed in the rejection of claim 10. It is therefore rejected under the same rationale.

As per claim 14:

Gibson discloses the system of claim 13, wherein said system is organized in three main modules comprising: a model definition module for defining geometry and physics of said deformable object (Fig. 10); a simulation module for obtaining deformed shape of said deformable object (Fig. 7); and a rendering module for enabling user interaction with said deformable object (Fig. 7).

As per claim 15:

Gibson discloses the system of claim 13, wherein said system is organized in three decoupled means comprising: means for simulating deformations of said deformable object (Abstract lines 6-7); means for rendering graphics (Fig. 7); and

means for rendering haptics (Fig. 8), wherein said decoupled means are executed concurrently in different processing means and wherein said decoupled means share a data structure containing said plurality of long elements.

As per claim 16:

Gibson discloses the system of claim 13, wherein said system is implemented in a client-server architecture allowing multi rendering and multi haptic interactions in a shared virtual environment (page 10 paragraph two).

As per claim 17:

Gibson discloses the system of claim 13, wherein said system is implemented in a network environment such that a plurality of users may simultaneously interact with said modeling (page 10 paragraph two).

As per claim 18:

Gibson discloses the system of claim 17, wherein said network environment is Windows. TM. NT, Unix, or the Internet (page 10 paragraph two lines 4-7 and page 11 paragraph two lines 1-2).

As per claim 19:

Gibson discloses the system of claim 13, wherein said system is implemented in a portable device (page 11 paragraph two lines 1-2).

As per claim 20:

Gibson discloses the system of claim 13, wherein said system is implemented in a personal computer (page 11 paragraph two lines 1-2).

5. Claims 21-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xunlei Wu, Michael Downes, Tolga Goktekin, and Frank Tendick, " Adaptive Nonlinear Finite Elements for Deformable Body Simulation Using Dynamic Progressive Meshes", Eurographics 2001, Vol. 20, No. 3, herein referred to as **Wu**, "Preliminary Finite Element Analysis With SAGE", 2000, herein referred to as **PFEAS**, and Sara Gibson, Christina, Eric Grimson..., Volumetric Object Modeling for Surgical Simulation, MIT, 5 November 1997, herein referred to as **Gibson** as applied to claims 1-20 above, and further in view of U.S. Patent No. 6,259,453 issued to Itoh, herein referred to as Itoh.

As per claim 21:

Wu discloses Long Elements Method (LEM) for real time physically based dynamic simulation of a deformable medium (Abstract), comprising the steps of: meshing said deformable medium based on b.sup.2 where b is length of a side of said deformable medium (*These matrices are generally...;* page 2, left side column, lines 10-12).

Wu fails to disclose generating a plurality of long elements wherein each of said plurality of long elements is one-dimension entity; simulating in at least two different dimensional spaces simultaneously, wherein said at least two different dimensional spaces comprising lower order dimensions and higher order dimensions.

PFEAS discloses generating a plurality of long elements wherein each of said plurality of long elements is one-dimension entity (page 327, under a title "B.3 Shearing of a Thin 2-Delement of Soil Bentonite" lines 1-2 and page 321 the title "One-Dimension Consolidation").

Itoh discloses simulating in at least two different dimensional spaces simultaneously, wherein said at least two different dimensional spaces comprising lower order dimensions (col. 1 lines 11-15) and higher order dimensions (col. 1 lines 25-30).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to combine the teachings of Wu related to produce a diagonal mass matrix that allows real time computation with the teaching of PFEAS related to perform verification of the RS model in SAGE, analysis of arching in a soil Bentonite cutoff wall, and shearing of thin 2-D element of soil bentonite and with the teachings of Itoh related to automatically generating a mesh such as quadrilateral, hexahedral, and the like. The motivation for doing so would have been more convenient to show reasonable stress-strain behavior (**PFEAS**, page 327 lines 14-15), and to divide a geometric model generated computer design (Cad) into a set of small elements (**Itoh et al.**, col. 1 lines 9-11). Hence a skilled artisan having access to the teaching of Wu, PFEAS and Itoh would have knowingly modified the teaching of Wu with PFEAS and Itoh.

As per claim 22:

Itoh discloses projecting said deformable medium into a plurality of representations in lower order dimensions; and crossing said deformable medium with a plurality of reference planes of lower order dimensions, wherein points inside said deformable medium are simulated with respect to relative positions on said reference planes (col. 3 lines 6-13).

As per claim 23:

PFEAS discloses plurality of long elements comprising straight long elements and free form long elements (*These matrices are generally...;* page 2, left side column, lines 10-12).

As per claim 24:

Itoh discloses at least two different dimensional spaces comprising a one-dimension long element space (col. 1 lines 11-3) and a three-dimension Cartesian space (col. 1 lines 25-30).

As per claim 25:

The limitation of claim 25 has already been discussed in the rejection of claim 21. It is therefore rejected under the same rationale.

As per claim 26:

Gibson discloses The system of claim 25, wherein said means for simulating further comprising a deformation engine for simulating stateless deformations of said deformable medium (page 1 under a title "Introduction" paragraph two lines 1-5) and a dynamic simulation computing means for providing state-based dynamic simulation and for integrating said stateless deformations and said state-based dynamic simulation (page 4 lines 1-3), said computing means deriving three-dimension shape of said deformable medium from configuration of said plurality of one-dimension long elements (Fig. 7).

As per claim 27:

The limitation of claim 27 has already been discussed in the rejection of claim 24. It is therefore rejected under the same rationale.

As per claim 28:

The limitation of claim 28 has already been discussed in the rejection of claim 23. It is therefore rejected under the same rationale.

As per claim 29:

The limitation of claim 29 has already been discussed in the rejection of claim 22. It is therefore rejected under the same rationale.

As per claim 30:

The system of claim 25, wherein each of said plurality of long elements comprising a combination of two mass-less long elements attached to a particle of known mass.

As per claim 31:

The limitation of claim 31 has already been discussed in the rejection of claim 17. It is therefore rejected under the same rationale.

As per claim 32:

The limitation of claim 32 has already been discussed in the rejection of claim 18. It is therefore rejected under the same rationale.

As per Claim 33:

The limitation of claim 33 has already been discussed in the rejection of claim 19. It is therefore rejected under the same rationale.

As per claim 34:

The limitation of claim 34 has already been discussed in the rejection of claim 20. It is therefore rejected under the same rationale.

As per claim 35:

Gibson discloses the system of claim 25, wherein said system is implemented in a surgical interface (Fig. 1).

Conclusion

1. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Stephane Cotin, Herve Delingette, and Nicholas Ayache, Real-Time Elastic Deformations of Soft Tissues for Surgery Simulation, Vol. 5, No. 1 1999 IEEE.

Morten Bro-Nilesen and Stephane Cotin, Real-Time Volumetric Deformable Models for Surgery Simulation using Finite Elements and Condensation, Vol. 15, No. 3, EUROGRAPHICS 1996.

Bowden, R., Mitchell, T. A., Sahardi, M., "Real-time Dynamic Deformable Meshes for Volumetric Segmentation and Visualisation", BMVC 1997, Vol. 1, pp 310-319.

U.S. Patent No. 6,007,319 issued to Jacobson et al.

U.S. Patent No. 6,804,635 issued to Dhondt et al.

U.S. Patent No. 5,877,777 issued to Colwell et al.

2. Any inquiring concerning this communication or earlier communication from the examiner should be directed to Kibrom K. Gebresilassie whose telephone number is (571) 272-8571. The examiner can normally be reached on Monday-Friday, 8:30 am to 4:30 pm. If attempts to reach the examiner by telephone are unsuccessful, the examiner supervisor, Kamini shah can be reached at (571) 272-2279. The official fax number is

(571) 273-8300. Any inquiring of a general nature relating to the status of this application should be directed to the group receptionist whose telephone number is (571) 272-3700.

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